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December 16, 2003

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APPLICATION NUMBER: *60/418,198*
FILING DATE: *October 11, 2002*
RELATED PCT APPLICATION NUMBER: *PCT/US03/32447*

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

N. WOODSON
Certifying Officer

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10-15-02 18198.1012 A/PR

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10/11/02 U.S. PTO

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

jc879 U.S. PTO 60/418198

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Vitaly M.	Pirozhenko	Moscow, Russia
Gary F.	Bowser	Auburn, Indiana
Vladimir M.	Belugin	Moscow, Russia

☒ *Additional inventors are being named on the one separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

ELECTRON STANDING-WAVE LINEAR ACCELERATOR

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☒ Customer Number 006980 (Type Customer Number here)

OR

006980
PATENT TRADEMARK OFFICE

☐ Firm or Individual Name					
Address					
Address					
City		State		ZIP	
Country		Telephone		Fax	

ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 8 ☐ CD(s), Number

☒ Drawing(s) *Number of Sheets* 2 ☒ Other (Specify) Check No. 299065; Unexecuted Declarations (4)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☒ Applicant claims small entity status. See 37 CFR 1.27

☒ A check or money order is enclosed to cover the filing fees

☐ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number 20-1507

☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT($) 80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government Agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE _____ Date 10 / 11 / 02

TYPED or PRINTED NAME R. Stevan Coursey

REGISTRATION NO. *(if appropriate)* 39,949

Docket Number: SCAN1.PRV

TELEPHONE (404) 885-3632

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C., 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

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PROVISIONAL APPLICATION COVER SHEET

Additional Page

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Docket Number	SCAN1.PRV	Type a plus sign (+) inside this box →	+

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
Nikolay E.	Rozanov	Moscow, Russia

Number 1 of 1

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PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Provisional Patent Application of: **PIROZHENKO, Vitaly M. et al.**	)	Group Art No.: **Unassigned**
Serial No.: **Unassigned**	)	Examiner: **Unassigned**
Filed: **October 11, 2002**	)	Atty. Ref: **SCAN1.PRV**
For: **ELECTRON STANDING-WAVE LINEAR ACCELERATOR**	)	

"Express Mail" Mailing Label Number: EL812796915US
Date of Deposit: October 11, 2002
I hereby certify that this correspondence and the papers described herein are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above to the Commissioner for Patents, Box Provisional Patent Application, Washington, D.C. 20231.

R. STEVAN COURSEY
Reg. No. 39,949

Signature

TRANSMITTAL LETTER

October 11, 2002

Commissioner for Patents
Box Provisional Patent Application
Washington, D.C. 20231

Sir:

In connection with the above-identified United States Provisional Patent Application which is being filed herewith under 35 U.S.C. § 111(b), enclosed please find the following documents for filing:

1. Provisional Application for Patent Cover Sheet;

2. Unexecuted Declarations for Provisional Patent Application (4);

3. United States Provisional Patent Application of Vitaly M. Pirozhenko, Gary F. Bowser, Vladimir M. Belugin, and Nikolay E. Rozanov, including: 8 pages of specification, 2 claims, and 2 sheets of drawings;

4. Check No. 299065 in the amount of $80.00 in payment of the Provisional Patent Application Filing Fee;

5. Fee Transmittal for FY 2002; and,

6. Return Postcard.

Respectfully submitted,

TROUTMAN SANDERS LLP

By: _____
R. Stevan Coursey
Reg. No. 39,949
Attorney for Applicant

TROUTMAN SANDERS LLP
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FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision

TOTAL AMOUNT OF PAYMENT | ($) 80.00

Complete if Known	
Application Number	Unassigned
Filing Date	October 11, 2002
First Named Inventor	Pirozhenko, Vitaly M.
Examiner Name	Unassigned
Group Art Unit	Unassigned
Attorney Docket No.	SCAN1.PRV

METHOD OF PAYMENT

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number: 20-1507

Deposit Account Name: TROUTMAN SANDERS LLP

☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

☒ Applicant claims small entity status. See 37 CFR 1.27

2. ☒ Payment Enclosed: ☒ Check ☐ Credit card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
114	160	214	80	Provisional filing fee	80.00
				SUBTOTAL (1)	($) 80.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below		Fee Paid
Total Claims		-20** =		X $	= $
Independent Claims		- 3** =		X $	= $
Multiple Dependent					=

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent
				SUBTOTAL (2) ($) 0.00

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for ex parte reexamination	
112	920*	112	920*	Requesting publication of SIR after Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	218	460	Extension for reply within third month	
118	1440	218	720	Extension for reply within fourth month	
128	1960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1280	241	640	Petition to revive - unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	740	246	370	Filing a submission after final rejection (37 CFR 1.129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	
Other fee (specify)					
* Reduced by Basic Filing Fee Paid				SUBTOTAL (3)	($) 0.00

SUBMITTED BY

Name (Print/Type)	R. Stevan Coursey	Registration. No. (Attorney/Agent)	39,949	Telephone	404-885-3632
Signature				Date	October 11, 2002

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ELECTRON STANDING-WAVE LINEAR ACCELERATOR

FIELD OF THE INVENTION

The invention concerns the field of particle acceleration technology, specifically the technology of electron linear accelerators. It may be used for the development of linear accelerators of high-intensity electron beams which are applied for the investigations in physics and radiation chemistry and for radiation technologies - sterilization of medical devices, prolonging the shelf life of foodstuffs, modification of materials properties and so forth.

BACKGROUND OF THE INVENTION

Electron linear accelerator is the most commonly used type of accelerator for obtaining electron beams with energies of several or several tens megaelectronvolts.

Since the early days of linear accelerator technology, the electron accelerators with traveling wave were used throughout. In this type accelerator iris-loaded waveguide is used as accelerating system. But traveling-wave accelerators have a number of drawbacks: low efficiency of acceleration, bad flexibility in the parameters selection and optimization, and the absence of possibility to accelerate the electron beams with high intensity.

For these reasons in recent years electron linear accelerators with standing wave are developed and used. They displace the traveling-wave accelerators in the conventional areas as well as open up new possibilities for improvement of parameters and new areas of electron accelerators application.

Usually an electron standing-wave accelerator comprises an electron injector, an accelerating resonator, a radio-frequency generator to feed the resonator, a solenoid for focusing the electron beam, and means for vacuum pumping, power supply and control. Accelerating resonator is designed as a biperiodic structure in the form of a chain of coupled cavities with $\pi/2$-mode of operation. Accelerating cavities alternate with coupling cavities, phase shift between adjacent cavities is $\pi/2$ and between accelerating cavities is π. Several versions of design of standing-wave $\pi/2$-mode structure is used differing by the cavities shape. In particular, "Disk And Washer" accelerating structure offers the most stability of accelerating electromagnetic field and is most suitable for acceleration of high-intensity electron beams.

In order to increase the number of electrons captured to the acceleration, preliminary bunching of the electron beam is often made. In the standing-wave accelerators, bunchers of klystron type are used. Such type buncher contains cylinder-shaped cavity and drift space after it. When the electron beam goes through the cavity, it receives a modulation of electrons energy and velocity. When the beam is going in the drift space, the modulation of velocity is transformed to modulation of density. The beam comes to entrance of the accelerating resonator being bunched.

Electron linear accelerator comprising buncher of klystron type and standing-wave $\pi/2$-mode accelerating structure may be selected as a prototype.

Klystron type buncher can not provide good bunching and high efficiency of capture of the electron beam to radio-frequency acceleration mode. Usually phase extent of the beam bunch is large (1-1.5 radian). When long bunch is accelerated in the accelerating resonator, electrons receive different increments of energy, and the electron beam at the accelerator exit has large energy dispersion (10-20%). Particularly large energy dispersion takes place when high-intensity beam is accelerated. In this case electrons in the bunch experience large forces of space charge which retard the forming of compact bunch. At very high intensity of the beam, this type buncher can not form any bunches. So usual linear accelerator with buncher of klystron type can not provide obtaining high-intensity beams of accelerated electrons.

Additional demerits of known scheme of accelerator are some complicity of design and poor stability of operation. Since bunching and accelerating resonators are separated by drift space, they are supplied by radio-frequency power using individual feeders, for example, waveguides. Vacuum pumping is executed from each resonator individually. These features cause some problems in the accelerator designing because the bunching resonator should be located inside the beam focusing solenoid. Besides, change of temperature, bad contacts and other factors cause unstable difference of phase of electromagnetic field between the resonators which worsen the accelerated beam characteristics.

SUMMARY OF THE INVENTION

At present a topical problem is development of linear accelerator providing high-intensity electron beam with high energy and small energy dispersion.

Method for solving the problem is the following. Electron beam incoming from an injector is bunched by electromagnetic field that acts on the beam on all length of the buncher, so that a drift space is absent. The electromagnetic field is excited in extended bunching resonator that is designed as a chain of coupled cavities and adjoined to entrance of an accelerating resonator. Continuous action of the electromagnetic field of the bunching and accelerating resonators balances forces of the beam space charge on all the way from the injector to the accelerator exit.

The extended bunching resonator is calculated so that bunching the beam is executed adiabatically and coincidentally with beginning the acceleration. This gives the possibility to bunch high-intensity beam to compact bunches because effect of the forces of the beam space charge is much moderated at higher energy of electrons.

For adiabatic bunching, lengths of the resonator cavities and amplitudes of electric field in them should rise along the buncher, with large relation (5-10) between the amplitudes in the last and in the first cavities. This relation may be obtained in a chain of coupled cavities by proper choice of resonant frequencies of the cavities which are determined by their dimensions.

Absence of the drift space makes it possible to perfect the accelerator design and improve the stability of its operation. It is expedient to adjoin the bunching and accelerating resonators together to form a single design. Existence of common wall between the resonators enables us to form electromagnetic coupling of them and to energize both the resonators by single radio-frequency generator using one feeder. Absence of individual feeders eliminate instabilities of phase of the electromagnetic fields in the resonators which could worsen the beam characteristics.

In some cases it may be expedient to use a standing-wave $\pi/2$-mode structure in the bunching resonator. In this structure bunching cavities alternate with coupling cavities which produce resonant coupling between the bunching cavities and provide low sensitivity of the field distribution to the beam loading. Required character of distribution of the field amplitudes in the bunching cavities is obtained by choice of coupling coefficients between the bunching and coupling cavities. This design is preferable for bunching and acceleration of high-intensity beams, but due to slow rising the field amplitudes, the bunching resonator should be longer.

In specific cases it may be expedient to produce resonant coupling between bunching and accelerating resonators. For this purpose it is necessary to place two separating walls between the resonators. Interspace between the walls fulfils the role of resonant coupling cavity. This design

is preferable for obtaining more stable relation of the field amplitudes in the bunching and accelerating resonators but it has some more complicated design.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 - Electron standing-wave linear accelerator in which bunching resonator represents chain of coupled cavities operating on π-mode.

Fig. 2 - Cross-section of bunching resonator.

Fig. 3 - Cross-section of separating wall between bunching and accelerating resonators.

Fig. 4 - Scheme of accelerator design in which bunching resonator represents biperiodic chain of coupled cavities operating on $\pi/2$-mode.

Fig. 5 - Scheme of accelerator design in which bunching resonator represents biperiodic chain of coupled cavities operating on $\pi/2$-mode, and two separating walls are installed between the resonators forming resonant coupling cavity.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Electron accelerator shown on Fig. 1 comprises following components:

- electron injector comprising electron source 1 containing cathode with heater, high-voltage insulator 2, and power supply block 3;
- bunching resonator containing coupled cavities 4, 5, 6, 7;
- accelerating resonator containing casing 14, discs 15, washers 16;
- separating wall between the resonators 12;
- focusing solenoid 11;
- radio-frequency generator 18 with feeder 19;
- means for vacuum pumping 20;
- means for power supply and control (not shown on drawing).

The bunching resonator contains cavities with length rising along the electrons motion. The cavities are coupled through windows in the walls 8, 9, 10. Shape and location of the windows are shown on Fig. 2. Short drift tubes are placed on the axis in order to concentrate electrical field near the axis. Shape of the cavities may be optimized, in particular edges and corners may be rounded off to decrease electrical field intensity and microwave power loss.

The accelerating resonator represents Disc And Washer accelerating structure. Conducting washers 16 are fastened to discs 15 by means of bars 17 placed in nodes of the electric field. Channels for cooling water may be located inside the bars. In the structure cylindrical volume on the axis between the washers is accelerating cavity, volume on periphery between the discs is coupling cavity.

Separating wall 12 between the bunching and accelerating resonators has aperture on the axis for the electron beam passage and window on periphery 13 for magnetic coupling the resonators. Shape of the separating wall is shown on Fig. 3.

Radio-frequency generator 18 is connected to the accelerating resonator using feeder 19 of waveguide type. The feeder is connected to the last cavity of the resonator through coupling window. Vacuum pumping of the accelerator is executed through the feeder.

The accelerator operates in the following way. The electron source emits electron beam 21. The beam is preliminary accelerated in the injector gap and comes to the bunching resonator. The radio-frequency generator excites electromagnetic wave in the accelerating resonator. The electromagnetic wave energy is passed to the bunching resonator through the window in the separating wall. The cavities in the bunching resonator are adapted so that π-mode is excited in the resonator, i.e. phase shift in adjacent cavities is π. Amplitudes of the electric field in the cavities vary in a predetermined fashion. The amplitude in the first cavity is less than injection voltage, so all electrons pass to the second cavity and begin to bunch around electrons with the phase that equals to zero. Longitudinal dimensions of the cavities and amplitude of the field in the second cavity are chosen so that the beam continues to bunch and receives some increment of energy, i.e. begins to accelerate. In the following cavities of the bunching resonator, the resulting bunch decreases its phase extent and becomes more compact coincidentally with increasing its energy.

When the process of forming the bunch ends, electrons have rather high energy. Effect of force of the beam space charge is in inverse proportion to, $\beta\gamma$, where $\beta=v/c$ is relative velocity of an electron, v - velocity of an electron, c - velocity of light, $\gamma=E/E_o$, E - full energy of an electron, E_o -energy of an electron at rest. Thus the electron beam comes to entrance of the accelerating resonator in the form of compact bunches in which the space charge forces are attenuated.

Thickness of the separating wall is chosen so that middle of the beam bunch goes through middle of the first cavity in the accelerating resonator when the electric field in it is maximum. Under this condition the bunch obtains maximum increment of energy in the first cavity of the accelerating resonator. Phase shift of the field in adjacent cavities in the accelerating resonator is π, longitudinal dimensions of every cavity is equal to $\beta\lambda/2$, where λ is wavelength in free space. So in a time of transit of the bunch through the first cavity, the electric field in the second cavity becomes also accelerating and the bunch obtains maximum increment of energy in it, and so on. At this movement of the bunches, relative spread of energies is minimum and equals approximately $\Delta E/E=\Delta\varphi^2/8$, where $\Delta\varphi$ is phase extent of the bunch. This choice of the cavities dimensions provide maximum energy and minimum energy spread of accelerated electrons.

The solenoid performs focusing the electron beam on overall length of the bunching and accelerating resonators providing transverse stability of the electron beam with any intensity, including high intensity.

Synchronism and proper relation of phases in the bunching and accelerating resonators are ensured by the fact that both resonators are fed by single radio-frequency generator. The feeder is connected to the accelerating resonator that consumes main part of microwave power. The power is transferred to the bunching resonator through the window in the separating wall. Coupling the resonators should be sufficiently strong to conserve proper relation of phases in the resonators under the beam loading. At low-intensity beam acceleration, required coupling coefficient can be received using one coupling window. At high-intensity beam acceleration, the coupling coefficient should be increased, using 2, 3, or 4 coupling windows in the separating wall. The feeder and means for vacuum pumping may be located at the end part of the accelerator that alleviates the task of the accelerator designing.

On Fig. 4 is shown accelerator in which bunching resonator represents a biperiodic chain of coupled cavities. Bunching cavities 4, 5, 6, 7 alternate with coupling cavities 21, 22, 23. All cavities are adapted so that the resonator operates on standing-wave $\pi/2$-mode. Electromagnetic fields in neighboring bunching cavities are opposite in direction. Fields in the coupling cavities are small, these cavities serve to produce resonant coupling between the bunching cavities. Designed field distribution in the bunching cavities is obtained by the proper choice of coefficients of coupling between the cavities. For example, relation between amplitudes of electric field in the cavities # 4 and 5 is equal to $E_4/E_5=k_5/k_4$, where k_4 is coefficient of coupling

between the cavities # 4 and 21, k_5 is one for the cavities # 5 and 21. The coupling coefficients are determined by number and dimensions of coupling windows between the cavities.

The accelerating resonator also operates on standing-wave $\pi/2$-mode. The separating wall is contiguous with the last bunching cavity of the bunching resonator and the first accelerating cavity of the accelerating resonator.

On Fig. 5 is shown scheme of accelerator design in which bunching and accelerating resonators represent biperiodic chains of coupled cavities operating on $\pi/2$-mode and two separating walls 24 and 25 are placed between the resonators. There are the apertures on the axis for the electron beam passage and coupling windows 26 and 27 in the walls. Dimensions are chosen so that space between the walls is resonant at operating frequency and fulfils the role of resonant coupling cavity. Required relation of electric fields in the resonators is obtained by the proper choice of coupling coefficients which are determined by dimensions of windows 26 and 27.

An example of the specific realization can be illustrated in the form of list of parameters of the proposed accelerator which are calculated using method of numerical modeling of the electron beam dynamics. The accelerator parameters are following:

Energy of accelerated electrons	5 MeV
Current of beam of accelerated electron	100 A
Operation frequency	2856 MHz
Number of cavities in bunching resonator	4
Number of cavities in accelerating resonator	10
Dispersion of energy of accelerated electrons	6 %
Capture coefficient	70 %

Existing buncher of klystron type can not bunch the beam with such high current to compact bunches. If high-intensity electron beam is injected, it is chopped in accelerating resonator forming electron bunches. As a result, the capture efficiency and current of accelerated beam are less (at least by factor 2) and the energy dispersion is large.

Therefore proposed accelerator provides obtaining the beam of accelerated electrons with more current and much less energy dispersion than existing accelerators. Besides, it has more simple design and better stability of operation.

CLAIMS

What is claimed is:

1. An apparatus as described herein and as shown in the Figures, including each and every limitation and embodiment.

2. A method of operation as described herein and as shown in the Figures, including each and every limitation and embodiment.

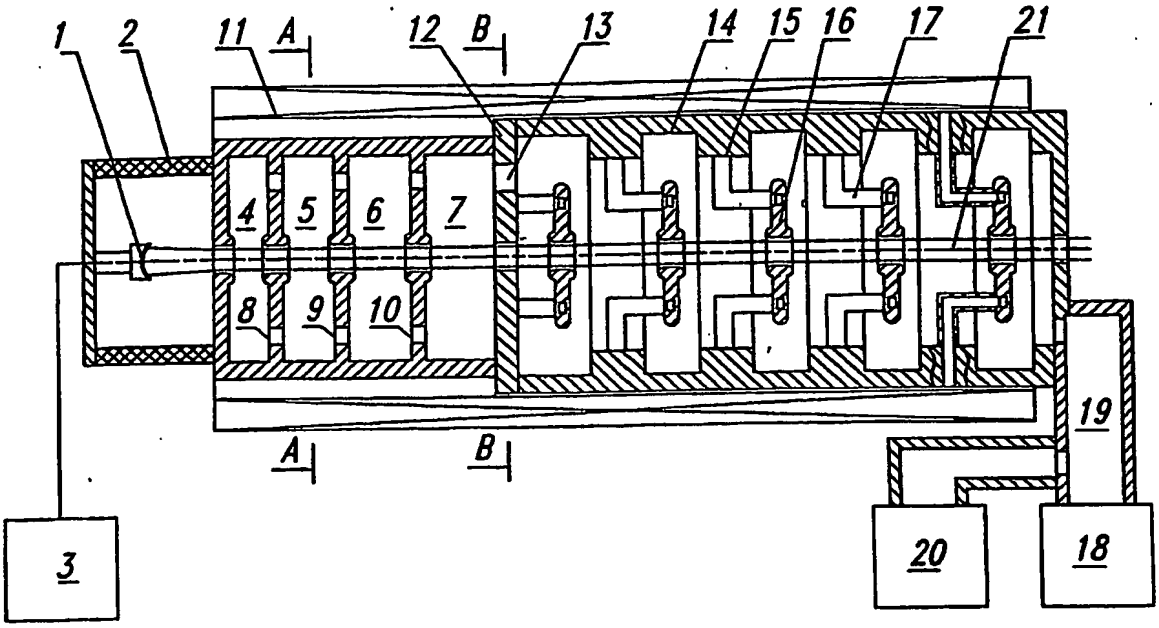

Fig. 1

A–A

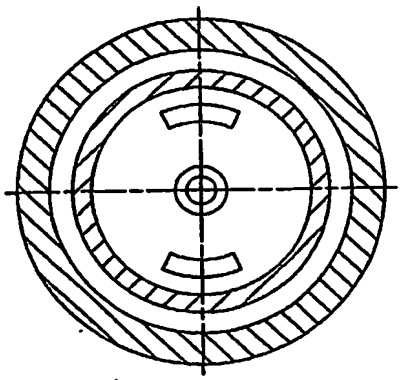

Fig. 2

B–B

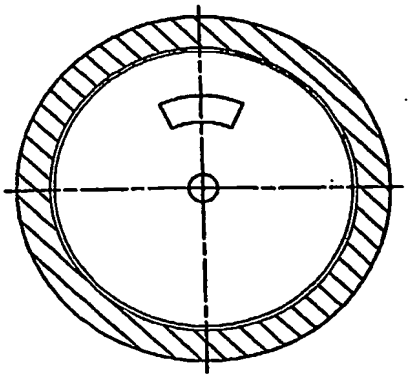

Fig. 3

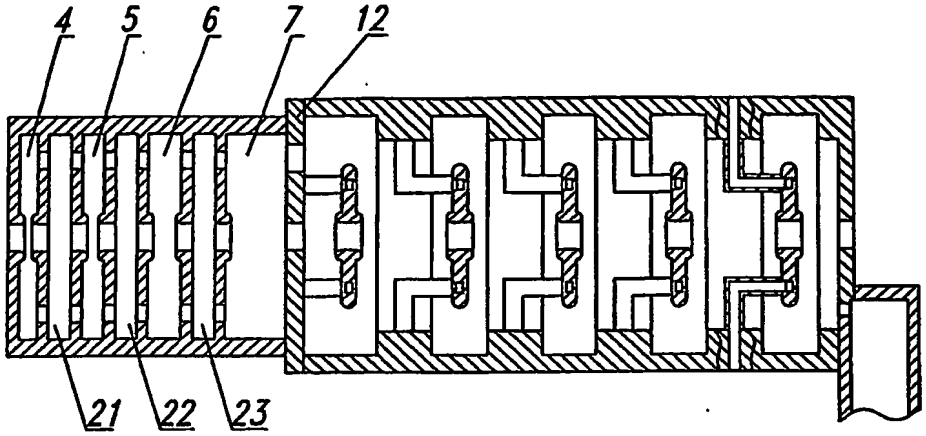

Fig. 4

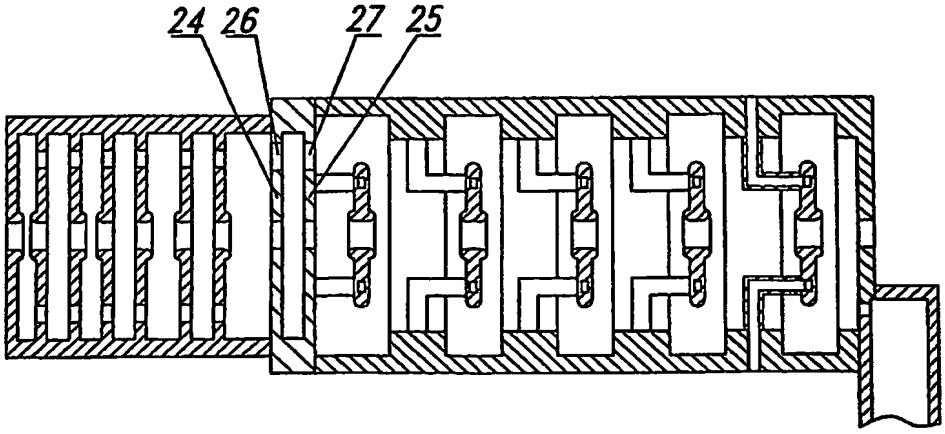

Fig. 5

60141.R19R - 1.01.102

DECLARATION AND POWER OF ATTORNEY

In R[redacted]plication: Pirozhenko, Vitaly M. et al. Attorney's Docket No.: SCAN1.PRV

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name. I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled, **ELECTRON STANDING-WAVE LINEAR ACCELERATOR**, the specification of which:

- ☒ is attached hereto.
- ☐ was filed on ____ as Application No.____
- ☐ was amended on ___.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used by others in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to the date of this application. I further state that the invention was not in public use or on sale in the United States of America more than one year prior to the date of this application. *I understand that I have a duty of candor and good faith toward the Patent and Trademark Office*, and I acknowledge the duty to disclose information which is material to the patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of the foreign application(s) for patent or inventor's certificate listed below, and have also identified below any foreign application for patent or inventor's certificate disclosing subject matter in common with the above-identified specification and having a filing date before that of the application on which priority is claimed:

Application No.	Country	Filing Date	Priority Claimed Under 35 USC §119
_____	_____	_____	☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

Application Serial No.	Filing Date
_____	_____

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter disclosed and claimed in the present application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status of United States Application:
_____	_____	☐ Patented, ☐ Pending, ☐ Abandoned

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issuing thereon.

POWER OF ATTORNEY. I hereby appoint Troutman Sanders LLP, having a Customer Number of 006980, and the attorneys and agents that are associated with this Customer Number from time to time, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Send correspondence to: **TROUTMAN SANDERS, LLP**
Attention: Patent Docketing Clerk - 46th
600 Peachtree Street, N.E., Suite 5200
Atlanta, Georgia 30308-2216

Direct telephone calls at **(404) 885-3632** to:
R. Stevan Coursey, Reg. No.: 39,949

	First	Middle/MI	Last	
Full name of joint inventors:	Vitaly	M.	Pirozhenko	Citizenship: Russia
Inventor's signature				Date:
Residence and Post Office Address: 72-158/2, Warshawskoe shosse, Moscow 113405, Russia				

DECLARATION AND POWER OF ATTORNEY

In [redacted]plication: Pirozhenko, Vitaly M. et al. Attorney's Docket No.: SCAN1.PRV

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name. I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled, **ELECTRON STANDING-WAVE LINEAR ACCELERATOR**, the specification of which:

- ☒ is attached hereto.
- ☐ was filed on ____ as Application No.____
- ☐ was amended on ___.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used by others in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to the date of this application. I further state that the invention was not in public use or on sale in the United States of America more than one year prior to the date of this application. *I understand that I have a duty of candor and good faith toward the Patent and Trademark Office,* and I acknowledge the duty to disclose information which is material to the patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

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Application No.	Country	Filing Date	Priority Claimed Under 35 USC §119
_____	_____	_____	☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

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_____	_____

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R. Stevan Coursey, Reg. No.: 39,949

	First	Middle/MI	Last	
Full name of joint inventors:	Gary	F.	Bowser	Citizenship: United States
Inventor's signature				Date:
Residence and Post Office Address: 2702 CR 68, Auburn, Indiana 46706				

[redacted]

DECLARATION AND POWER OF ATTORNEY

In R[redacted]plication: Pirozhenko, Vitaly M. et al. Attorney's Docket No.: SCAN1.PRV

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Application No.	Country	Filing Date	Priority Claimed Under 35 USC §119
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Direct telephone calls at **(404) 885-3632** to:
R. Stevan Coursey, Reg. No.: 39,949

	First	Middle/MI	Last	
Full name of joint inventors:	Vladimir	M.	Belugin	Citizenship: Russia
Inventor's signature				Date:
Residence and Post Office Address: 16-13, Ladozhskaja str., Moscow 107005, Russia				

[redacted]

DECLARATION AND POWER OF ATTORNEY

In [redacted]plication: Pirozhenko, Vitaly M. et al. Attorney's Docket No.: SCAN1.PRV

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R. Stevan Coursey, Reg. No.: 39,949

	First	Middle/MI	Last	
Full name of joint inventors:	Nikolay	E.	Rozanov	Citizenship: Russia
Inventor's signature				Date:
Residence and Post Office Address: 504-49/3, Sudostroitelnaja str., Moscow 115407, Russia				

[redacted]